INCREASING AND IMPROVING PRODUCTION

BY

R. T. KENT

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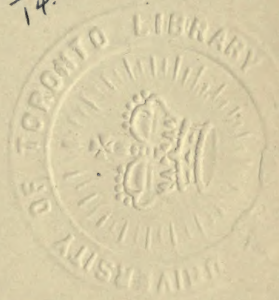

Published by
WESTINGHOUSE LAMP COMPANY
New York

PRINTERS
J. Romaine Co.
NEW YORK

Introduction

Ever since he graduated from Stevens Institute in 1902, Mr. R. T. Kent has been doing industrial efficiency work of the kind described in "Increasing and Improving Production."

He has been identified with concerns like the Robins Conveying Belt Co., Link Belt Co., Cooke Locomotive Works and was directly associated with Frederick W. Taylor—a connection that continued up to Mr. Taylor's death.

Executives in the metal industry will recall many important articles by Mr. Kent which have appeared in the "Iron Trade Review," "Industrial Engineering" and "Iron Age" and are familiar with "Kent's Mechanical Engineers' Pocket Book," of which Mr. R. T. Kent is co-author.

Through this very wide experience in industrial plant organization in the development of special machinery and processes, and in industrial plant construction, Mr. Kent is well qualified to offer some new ideas on "Increasing and Improving Production."

Contents

CHAPTER I

Efficient Manufacturing

THERE is a certain plant in Philadelphia whose employees answer when asked where they work "I am a Smith-Jones man." They speak of their plant as a college man speaks of his college. This plant has established a reputation as one of the most efficient in the United States. Its delivery promises are almost invariably kept and the workmanship on its product is of a uniformly high standard. It gets and retains the highest class of workmen. Its reputation for men as well as product is widespread and one of its workmen in seeking another job needs little recommendation other than the mere statement that he is a Smith-Jones man. As a matter of fact, however, most of its men are too well satisfied to want to make a change. They take pride in being identified with this plant and appreciate the facilities that it affords them to do good work under pleasant conditions.

A walk around the plant reveals some of the causes of this efficiency and explains the pride that the men take in their work.

The Fundamentals of Efficient Manufacturing

Everything is arranged to facilitate production. There is a place for everything and everything is in its place. Partly finished material upon which work has been suspended is in the storeroom; finished material is in the stockroom. The place is not "cluttered" with tools, half finished work and material which is not needed. At the machines will be found only the work upon which the workman is occupied or for the next job ahead of him. Finished work is removed to the next operation. The decks are cleared for action.

Dirt and disorder do not exist in this plant. The superintendents are able to put their hands upon any particular item of

equipment, any piece of work or any part of any job at any minute of the day. There is absolute control of the movement of material through the plant by a system of routing work, directed by the office. There is no indiscriminate hunting on the part of the men for the materials for their next job.

Scheduling the Work

In this plant efficiency begins with the receipt of the order. The requirements are analyzed and the material needed is ascertained. Reservations are made against the supply in the storeroom and the purchasing agent is requested to purchase such as are not already on hand. Then the manufacturing problems are studied and a definite schedule and time table for the manufacturing operations on every piece entering into the order is laid out. It is definitely known in advance just when each part will reach a particular machine and what tools are needed when it does. The tools and the piece are at the machine before the man has finished his previous job. There is no delay in starting work at any stage of the proceeding.

At night a scientifically designed system of artificial illumination makes the plant as light as it is by day.

The Causes of Delay

The causes of delayed work have all been hunted down and eliminated. Tools are maintained in the best of condition. Drinking fountains are placed at convenient points so that the men lose no time walking long distances for a drink. The shop is kept amply warm in winter and is artificially cooled in summer. Windows are kept clean at all times so that there is plenty of natural light in the day time. At night a scientifically

designed system of artificial illumination makes the plant as light as it is by day. The decreased production of the early morning and late afternoon hours of the winter months is an unknown thing. This particular plant is almost the last word in efficient manufacturing.

Any owner can manufacture efficiently if he does the same things that this company does. He must make his shop efficient and then build up an efficient personnel.

Keeping the Machinery Busy

Efficient manufacturing demands that all equipment in the plant shall be kept in operation for the maximum possible number of minutes during the working day. "Speeding-up" properly should not imply forcing the workman to greater effort. Rather "Speeding-up" should mean an endeavor to keep the machinery running all the time, and to eliminate the causes of delay.

The Importance of Good Working Conditions

The efficient plant is the comfortable plant. The day has long passed when we expect good work and quantity production in dark, low ceilinged workrooms. The workman expects and has a right to demand that the plant be made comfortable both winter and summer. He is entitled to adequate ventilation and, above all, to good light. We cannot expect good work if we compel the workmen to ruin their eyesight by working in semi-darkness.

The lamp that makes it unnecessary for him to go to the window will soon pay for itself.

Efficient manufacturing

means the elimination of wasted effort. It means the stopping of false motions and making every movement count. The workman should not have to look for the casting he is to machine. It should be brought to him before he is ready for it. He should not find it necessary to go to the tool room for his tools. The tool room should send them to him before he has his work set up. He should not waste time by taking a trip to the grindstone to sharpen those tools. They should be ready for use when he gets them. While he is doing these unnecessary things his machine is not producing and his employer is paying good money for absolutely no return.

Avoiding Wasted Effort by Good Lighting

The workman who has to walk ten feet to a window to obtain sufficient light to set his calipers is decreasing the production of the shop whenever he shuts his machine down for such a purpose. Every machine should be so well lighted that no workman need ever move from it in order to see better. The lamp that makes it unnecessary for him to go to the window will soon pay for itself.

If every employer would spend a day in his factory noting how many minutes his machinery is idle unnecessarily and due largely to causes which are within *his* control, the resulting increase in production throughout the Country would be almost incredible.

Maintaining the Rate of Production with Good Lighting

In the average factory the early morning and the late afternoon hours of the winter days are the hours of lowest production. Several causes contribute to this, but the chief of them is poor light. If artificial illumination be provided which is the equivalent of daylight, it will be found that the production during the dark hours is equal to that during those hours when natural lighting is at its best. The eye strain resulting from poor light also has its effect on production. Eye strain is a prolific cause of fatigue and nothing affects production quite as quickly as does fatigue.

CHAPTER II

The Human Element

THE good workman is attracted to the good plant. A poor workman will be satisfied with poor conditions and poor tools. The good workman may tolerate them, but he will not be satisfied. He will, as soon as possible, seek the plant which offers him facilities commensurate with his ability and the most comfortable surroundings. It is worthy of note that the character of the plant has a direct bearing on the character and appearance of the men employed in it.

The workmen leaving the clean, well lighted and well kept plant at quitting time take pride in their personal appearance. As a rule they will be clean and in respectable, neat street clothes. They will usually be found to be high class workmen. The men leaving the dirty, dark and ill-kept plant will as often as not be in their working clothes, and a certain percentage of them will carry the grime of the factory to their homes. There is no question as to which class of men is the most desirable. There is no question as to which class of plant will get them.

The Workman and the Plant

It should be remembered that the workman must spend about one-third of his entire time in the factory. If he is a normal human being, he prefers that the factory shall be as clean and comfortable as possible consistent with the conditions of the work. He regards the condition of the plant as an index of the character of its owners. He will feel sure that if the employer is fair to the workman in the little details of light, cleanliness and sanitation, he also will be fair in the larger questions of wages, hours, methods and discipline. It has become almost axiomatic that the neat, clean, well-ordered plant is also the efficient plant. The workmen know this as well as the effi-

ciency engineer, and taking pride in their work will strive to keep the plant in this condition. In so doing, they cannot help but increase their production.

The Effect of Light on the Workman

The first requisite in shop cleanliness and neatness is good light both natural and artificial. It is human nature to practice cleanliness and orderliness in a well lighted room, just as it is to throw things into the corners of a dimly lighted room and to neglect to clean up when poor light hides the dirt.

Big windows do more than give good working light; they promote shop cleanliness and cleanliness in turn promotes production. Good artificial illumination produces the same results as good natural illumination—and is even of greater importance in its influence on the workmen. However small and dirty the windows may be, the brightness of the day will penetrate the room to some extent and have its stimulating effect and its influence on cleanliness. At night, however, the conditions are different. There is no brightness and cheer to filter in from the outside; it must come from the lamp, or not at all. Night light in the factory should rival the cheerfulness of bright day light and will well repay the owner for the additional current required. Dim light may be fine for the restuarant or for your den at home when you don't wish to read, but dim light in the factory is generally "dingy" light—and that's the kind that depresses instead of rests—the kind that inspires a workman to throw a quid of tobacco at some distant object. It is generally dingy because the lamps and shades are dusty and dirty—a condition to be expected in a factory that has never realized the psychological effect of good light.

Night light in the factory should rival the cheerfulness of bright day light.

The Importance of Good Working Facilities

The men appreciate efforts to make them comfortable. You occasionally hear a workman say "Nothing doing on the welfare work—put the welfare work money in my pay envelope and I'll do my own welfaring." Nevertheless, the workmen will gravitate to the clean and orderly plant where the working conditions are better than in the plant which makes no pretense of looking after the comfort of its employees.

Even if sentiments of humanity and labor legislation do not dictate requirements looking to the health and comfort of the workers plain, ordinary hard business sense does. The comfortable worker, the contented worker is the efficient worker. We gain little by stocking our factory with the best tools, installing the finest routing system and making the most elaborate time studies, if we do not provide the facilities to make the workman efficient. The best way to make him efficient is to make him comfortable. Idle machines are profit losers. Insufficient toilet rooms are prolific causes of idle machines. Cold workrooms also cut down production. No man can do accurate work with cold fingers. Insufficient ventilation makes the man listless and slow. Again is production cut down.

Lighting and Production

Poor lighting, especially in the winter, is often responsible for as much loss of production as all other causes put together. The effect of light on the workshop is both real and psychological. Adequate illumination at the machine enables the man to proceed as rapidly and as effectively as in daylight. There are no false movements and the job moves with the same snap and precision at all hours of the day. There is no time lost in adjusting the light to enable the workmen to look into dark corners. All these little things mean loss of production. When the workman is adjusting his lamp his machine is not producing and when it is not producing, it is losing profits and costing money.

The lamp that lights the machine has a more direct bearing on the production of that machine than most managers realize.

If there is not sufficient light to see without looking twice, it causes the workman to lose time and if this loss amounts to three quarters of a minute an hour, insufficient light costs more than good light. Right here it might be well to say that the cost of light is more a matter of time than of electric current. A lamp that costs one-half cent an hour in electric current may easily cost five cents an hour in lost time. On the other hand, one that costs three-quarters of a cent an hour may cost nothing in lost time.

What the Workman Thinks About It

A workman doesn't like to lose time due to poor light (even if he's the kind that will soldier when he gets a good chance) for your loss also affects him. He is pretty sure to feel it in the form of eye strain, eye fatigue, dizziness, or headache and he'd much rather work than suffer the inconvenience. If he has to walk to the window to adjust his micrometer, or if he has to strain his eyes to see or turn his head away to avoid glare, you pay for the lost time in money, he pays for it in discomfort.

The lamp that lights the machine has a more direct bearing on the production of that machine than most managers realize.

The better the workman the more particular he is about his surroundings. Many good workmen, however, soon acquire bad habits under poor working conditions.

It is human nature to become careless when the carelessness is not plainly visible to all. Good light makes careless work stand out in bold relief, while a poorly lighted shop may not be noticed.

leads to spoiled work, lessened production and accidents. With the insufficiently illuminated machine, the man may misjudge the position of unguarded gears or the length of stroke of a moving portion of the machine, such as the ram of a shaper. Such an error of judgment makes the chances more than even of getting hurt. Sufficient illumination minimizes or removes the chances of accident altogether.

CHAPTER III

Mistakes that Cost Money

IT was three o'clock one Friday afternoon in October, when Johnston, the best grinder in the shaft department, got a rush order for twenty-five shafts to be ground to exactly 1.751 inches diameter. By the time he had his machine set up and the first shaft in place, it was turning dusk, so he turned on the small unshaded electric lamp that was swinging over his machine, set his micrometer to 1.751 and started the cut. Johnston was a fast workman and in half an hour he had several shafts done and was proceeding merrily along with the rest of the work.

"Seems like there was an awful lot of stock to come off these shafts," he mused as he fed the wheel in for a little heavier feed and scowled as he thought of the lathe hand that had left so much surplus stock to be ground off. Just before six o'clock he called over to the boss inspector and said:

"Here's a lot of twenty-five shafts, just check them up so they can be shipped out tonight. It's as nice a lot of shafts as I ever put through, even if they *were* done in a rush."

The Inspector Finds a Mistake

The inspector got out his micrometer and measured the first shaft, looked puzzled, examined his drawing again and once more checked up the measurements. Then he tried another shaft, but the puzzled expression still remained on his face, and he looked up at Johnston and said, "Do you know that you've got these shafts all exactly twenty-five thousandths under the size called for in the drawing?" Johnston simply *knew* better, so he reached for his micrometer that he had set carefully at the start of the job, and tried it on

the shaft. It slipped over just right with just the right feel of a good fit.

"Let's see that micrometer," said the inspector. He looked at it closely but because of insufficient light was unable to see the marking. He walked over to his own bench where there was a large lamp and examined the micrometer carefully.

"Why, you've got this set for 1.726," he exclaimed, "and if you've ground to that size every one of these shafts has been spoiled."

Johnston was thunderstruck! He went over under the inspector's light, examined his micrometer and found that he had miscalculated in setting it. There was only one .025 graduation showing about the 700 mark instead of two as there should have been.

Regrets were of no use. Every one of the twenty-five shafts went to the scrap pile and all the labor of cutting off, centering, turning, hardening and grinding was a dead loss—all for the want of proper light.

Poor Lighting Causes Costly Errors

Mistakes like these happen every day in metal working plants all over the country. Some are unavoidable but most of them can be avoided by the provision of proper working facilities and the exercise of care.

In the case described in this chapter, which is typical, the mistake was due entirely to the lack of proper lighting. Inadequate light is the cause of $28,000,000 worth of spoilage in American factories

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in a year and yet many plants seem to consider the question of lighting as unimportant. It must be obvious that no plant can afford to provide poor lighting facilities for the workmen. Not only does inadequate light cause mistakes but it decreases production because, if in order to avoid errors, the men have to work slowly and hesitatingly under poor light, there is big loss in time that is very expensive.

The cost of good lighting is insignificant compared with the amount of spoilage and time it saves and this is one of the ways to avoid mistakes that cost money.

CHAPTER IV

Preventative Repairs

THE general manager, walking through the shop, noticed the largest planer shut down. There was a job in the machine, but the belt was broken. Half an hour later he passed the machine again, and noticed a belt fixer at work. He made a mental calculation and then sent for the superintendent. "Do you know what that broken belt cost us?" he asked. "Why, the wages of the belt fixer, and the cost of the material to make repairs," replied the superintendent. "You are wrong," said the manager. "It cost us that, but it also cost us the wages of the machinist who stood idle while the repairs were being made and we lost the earning power of the machine, which is rated at $10. an hour. It you had your belts inspected regularly and repaired at night or during noon hours, we wouldn't have any expensive machine shut downs. Idle equipment makes no money. On the contrary it costs us money."

The Time to Make Repairs

Maintenance of equipment is a factor that has a direct influence on production. In the poorly managed shop, repairs are not made until the equipment breaks down. In the well arranged shop, repairs are "preventative." A system is instituted whereby every item of equipment is inspected at regular intervals. Wear is detected and repairs made before the danger point is reached.

The single item of productive time saved by a system of preventative repairs on belts has in some factories paid for all the new belting used in the plant.

The same idea has been applied to all the machinery and equipment in progressive factories. A lathe used with its carriage traveling

constantly over but a short distance on the ways in time becomes inaccurate for work of greater length. A system of maintenance or preventative repairs would provide for a periodical inspection of all parts of the lathe subject to wear and a rectification of all the errors so discovered. The importance of this is greater than most managers realize.

The Kind of Repairs that are Important

A system of preventative repairs establishes standards for everything and then insures the maintenance of these standards.

Shafting and loose pulleys are oiled at regular intervals so that there are no shut downs due to hot boxes or loose pulleys seizing on the shafts.

Fire hose is kept ready for use so that it will not burst and kink when suddenly called into service.

Fire doors are kept in order so that they will always operate properly and will not jam in an emergency.

The proper lamps are kept in every socket.

The proper lamps are kept in every socket, burned out lamps are replaced promptly and those lamps that show signs of deterioration are renewed.

Attending to the Lighting System

Attention to the lighting system should go a step further to see that every workman has adequate light, that he does not lose time due to poor or insufficient light and that the lamp is located so as not to cause him discomfort. A close

observation of the lighting of the different machines may reveal conditions, the improvement of which will mean much to the plant in the saving of time and the prevention of mistakes.

Sometimes a workman will remove a shade because he thinks it is not correctly designed for his work and as a result unconsciously strain his eyes on account of the glare of the bare lamp.

Sometimes the vibration of a machine seriously interferes with the effectiveness of the light and the right system of preventative repairs will see a way to overcome this condition.

In general preventative repairs are simply an extension of the principles of good housekeeping throughout the plant. They are looked after by a regular department, working on a regular production schedule. This department, even if it consists of a single man, is one of the most important in any factory.

CHAPTER V

The Twenty-Four-Hour-a-Day Plant

THE plant had suddenly been confronted with the problem of more than doubling its output. It was manufacturing a specialized product, which the War Department wanted, wanted it in a hurry, and wanted a lot of it. The manufacturing executives were in council with the president and the general manager. The big question put to them was not could they make the extra product but how quickly and how efficiently could they make it. The problem finally simmered down to two solutions—extension of plant or working a night shift. Raising the efficiency of the force did not meet the difficulty. It was already highly efficient and the organization and methods were of the best.

The manufacturing men were almost a unit in favor of the plant extension. They objected to night work on several grounds. They claimed that night work was more expensive. The same amount of product could be turned out by the day crew at a far lower cost. Why? They didn't know. Further they said, good men wouldn't work on the night shift. The quality of labor available for night work would be far below that which could be secured for day work. In short, night work, whichever way you looked at it, was bad and they would have none of it if there was any other way out.

The Necessity for Night Work

The President and the General Manager looked at the problem from a different angle. They appreciated all the arguments of the manufacturing men, but they saw, too, the heavy investment involved in plant extension and the possibility of having this extra plant on their hands when the war demand ceased. Then there was the question of delay. It takes time to construct buildings and get

machinery and although they had a contractor who was ready to have the roof on in six weeks, production should not be delayed that long. So they inquired more in detail as to the causes of the inefficiency of night work. The men admitted that if daylight conditions were reproduced at night, the product should be equal in volume and quality. The most important factor was admitted to be illumination. But this bugaboo was soon laid. It is possible to reproduce daylight conditions, even improve on them so far as illumination is concerned.

The Relation of Lighting to Night Production

The general manager was of the opinion that the quality of labor available for night work could be improved by training and intelligent supervision. He told how a friend of his, a successful factory manager, had solved the night work problem by making his shop at night as comfortable a place as it is in day time. The illumination is such that every part of it is as well lighted by night as by day. Some parts are better lighted. Then, instead of putting all his poorest help on the night shift he puts one-third of his best men on it. He arranges day and night shifts, so that each man works two weeks during the day and one week at night. The higher efficiency of the good men on the night force compensates for the premium he has to pay for this service. His poorer men have two weeks' training out of every three under daylight, and their efficiency is improved. Instead of there being a marked difference between the work of the night shift, both in quality and quantity of work, there is but little to choose between them.

Night work should offer no difficulties if the problem is approached in the proper manner. As stated before the one great factor is light. Not a lamp here and there at a machine where work is being done but a carefully worked

The most important factor was admitted to be illumination.

out scheme of scientific illumination is needed. The work rooms should be so well lighted that a man will no more think of turning on a light before starting his machine at night than he will of doing the same thing in the daytime. Such lighting will make the workers contented with their jobs, decrease spoilage,—the big problem of night work—and bring production up to daylight standards.

Proving the Effect of Light on Production

If you don't believe that light has a marked effect on production, put a job in a shaper and try to plane to a scribed line. See how long it will take if the line is in shadow, which is the case with 50 per cent of the shapers as they are illuminated today. Then illuminate the machine as it should be illuminated and time the job once more. Figure the value of the time lost on the first trial and compare it with the cost of the good light. Turn a shoulder on a piece in a lathe under the same set of conditions. Note how much sooner the power feed will be thrown out and the shoulder "felt for" with the hand feed when good light is absent. Again calculate how much money would be saved by good light.

If you don't believe that light has a marked effect on production, put a job in a shaper and try to plane to a scribed line.

The experience of one large Cleveland factory shows that night work is not distasteful to good workers if the conditions of working are right. In this factory, one department was devoted to intricate assembly work. The illumination was revised so that the room was better lighted at night than by day. The assemblers, who were piece workers, requested to be put on night work because with

the good illumination they could assemble more machines and thereby earn more money.

The shop that is fitted for twenty-four-hour production, even if it does not operate on that basis, can reduce the high cost of overtime work.

CHAPTER VI

Thunderstorms

IF you notice that all the stacks of a big power station suddenly begin to smoke in the middle of a sunshiny afternoon, you may be sure that in a short time the sky will cloud over and a thunderstorm come up. Observers at distant points telephone to the station at the first sign of a storm, and preparations are made to handle the additional load it will impose.

A thunderstorm affects almost every line of industrial activity. It means more work for some and less for others. Outdoor work ceases entirely. Street cars have to haul passengers who would otherwise walk. Telephones are used instead of calls being made in person. The electric light plants have a heavy burden thrown on them and must put more boilers into service and start more turbines and generators to take care of the lights that will be switched on all over the city. Stores will do less business. Taxicabs will do more.

What a Thunderstorm Means to a Factory

Did you ever stop to think that a thunderstorm may prove a heavy item of expense to the factory? If the recurrence of thunderstorms has not been taken into account in laying out the plant, every time the heavy clouds gather during the summer, the factory will lose money. It is not necessary that the building be

There are but few industries that can maintain a high standard of production under twilight conditions.

struck by lightning and set on fire for a loss to occur. In a large plant particularly, the loss due to such a disaster may be insignificant in comparison with the loss in other directions that will be a necessary accompaniment of every thunderstorm that occurs.

Purely a Question of Lighting

Every thunderstorm diminishes the supply of natural light. For a short time, at least, the light is that of twilight. In severe storms, the darkness may approximate that of early evening. There are but few industries that can maintain a high standard of production under twilight conditions. There will be an inevitable slowing down in the efforts of all operatives, particularly those the accuracy of whose work depends on an adequate supply of light. Workers who use their hands rather than machinery will decrease their output to a startling degree, or will cease work altogether. A fifteen-minute stoppage of work on the part of 100 mechanics, will represent a loss in wages of nearly ten dollars. Then, too, there is the loss of profits on the product that might have been made in this period, and the loss due to the overhead expenses which go on whether the weather be clear or stormy. There is the further possibility of loss in the shape of spoiled work, which may be produced in the dim light. All told, if the probability of thunderstorms has been left out of consideration, the total loss may amount to a surprisingly large figure.

This loss will be minimized or entirely eliminated if provision has been made to furnish artificial light which will illuminate the factory to

Good illumination serves in another way to minimize the loss due to thunderstorms.

the same degree as daylight. True, illumination is necessary for the dark hours of winter, but many factories, operating for an eight-hour work day, will have all work done in daylight. In such circumstances, if no provision has been made for overtime work, the illuminating system is apt to be of a most unsatisfactory character. The thunderstorm then finds the factory unprepared for the unusual conditions and production suffers for lack of sufficient light to carry on the work.

Lighting, Thunderstorms and the Individual Worker

Good illumination serves in another way to minimize the loss due to thunderstorms. Many persons are nervous, and some, especially women, are almost paralyzed with fear during these disturbances. Every flash of lightning upsets them and the more vivid the flash the greater the fear. A person in this condition is of little or no value from the standpoint of production. They may even cause an actual loss by damaging work. The vividness of lightning is increased by the darkness that necessarily accompanies the storm; when, however, the plant is filled with brilliant illumination, the contrast between the light in the room and the lightning flash is not so marked, and the disturbing effect of the lightning is much diminished. Plain nervousness will be decreased or eliminated altogether, while the paralyzing fear will be reduced to a more or less greater degree of nervousness, whose influence on production will be much less severe. An illuminating system that will reproduce daylight conditions will probably pay for itself in one season of thunderstorms.

CHAPTER VII

Accidents

HENDRICKS was a high class tool maker, whose services were well nigh indispensable. The production of the jigs, gages and fixtures used in the plant depended on him and his two assistants. Hendricks, however, was the brains of the combination, and directed all the work of the tool room. Shortly after darkness had fallen one winter afternoon, when the plant was full of rush orders, Hendricks was sent for by the foreman of a department in another part of the plant. He took a short cut which led past the racks in which the steel stock was piled. The passage was lighted by a single 16 candlepower old style carbon lamp and Hendricks, walking rapidly in the dim light, did not see a piece of stock projecting from one of the racks, left in that position by a careless laborer. The end of the piece struck him fair on the temple, and Hendricks dropped as if he had been shot. He was badly hurt, and it was two weeks before he was able to return to work. Meanwhile the work of the tool room lagged, and the plant was handicapped in the production of new work for the lack of the tool equipment which was being made under his direction.

The Cost and Causes of Accidents

The loss on this case was many times the amount represented by Hendricks' individual earning capacity. Accidents generally cost more than the ledger shows, and are of most frequent occurrence when the shop is running full capacity and can least afford the handicap.

What happened to Hendricks illustrates the three great causes of accidents:

A—Poor light.
B—Carelessness.
C—Unguarded danger spots.

If the passage had been well lighted, as all passages should be, Hendricks would have seen the projecting bar and avoided it. If the laborer had not been careless, the bar would have been properly placed in the rack, and Hendricks would not have run into it. If the passage had been walled or railed off from the stock racks, Hendricks could not have unwittingly walked into danger. The saving of a few dollars in light and the price of a railing cost the company a few hundred dollars due to the delay in starting and completing an important order.

If the passage had been well lighted, Hendricks would have seen the projecting bar and avoided it.

Accidents are Caused by Poor Lighting

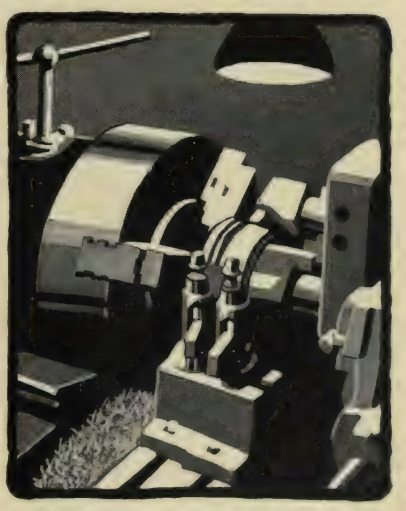
We have become so accustomed to thinking of accidents in connection with moving machinery, that we fail to realize that a large percentage of them have no connection whatever with machinery. Had Hendricks escaped the projecting piece of steel, he might have made a misstep on a poorly lighted stairway, or tripped on something left on the floor. State laws as a rule now require adequate safeguards, about all moving dangerous parts of machines. They are not so

rigid, however, about the provision of one of the greatest safeguards of all—adequate light.

It is unfortunate that large figures do not bring home to us the importance of things. In the case of industrial accidents, for example, the insurance companies state that 24% are due entirely to lack of sufficient light. If every manager of an industrial plant would consider this carefully and appreciate the fact that some of these accidents have happened in his plant, there would be fewer poorly lighted factories.

Good Lighting Prevents Accidents

There are some parts of machinery that cannot well be guarded by screens or mechanical methods. The workman must have access to them if he is to work at all. As a rule, these parts, while not necessarily dangerous, have the possibility of accident inherent in them. This possibility is increased by the absence of proper light. If the workman can see the danger, he will avoid it. Projecting chuck jaws, for instance, are almost invisible when the lathe is running at high speed, even when the illumination is good. When it is poor, it is next to impossible to tell just where the jaws are, and many a workman has been injured by being struck by them when filing close to the chuck. If artificial illumination is pro-



Projecting chuck jaws, for instance, are almost invisible —even when the illumination is good.

vided which is the equivalent of daylight, this source of accident will be reduced to a minimum.

The Effect of Accidents on Production

Accidents have a direct bearing on the production of the factory. In the first place the factory that is free from accidents, has, as a rule, more efficient workmen, better machines, more thorough inspection and maintenance than the factory which has a bad reputation for injuring its men. In the second place, an accident slows down the work of the men in the vicinity for a measurable length of time. It causes them to become excessively careful and it is not until the effects of the accident have worn off that they resume their normal pace, which in nine cases out of ten presents no undue risks.

Every workman will "take chances" rather than have his income suffer by decreased production. It is necessary to save the workman from himself. If he will not be careful on his own account, we must compel him to be careful in spite of himself. The easiest way to help the workman to be careful is to make it difficult for him not to be careful.

Statistics show that a large percentage of preventable accidents around the workshop result from tripping and falling.

The Human Element in Accidents

The greatest safety factor is carefulness. Despite all the safeguards, all the safety talks and all the efforts of safety committees, men will take chances. The only remedy is to so train them in habits of carefulness that carefulness becomes a second

nature. Accidents are expensive but it is hard to make the workman realize it until they happen to him.

Another phase of the accident problem which has not been considered in its relation to production is the fact that every accident puts a skilled worker out of commission for a greater or less length of time. This means an absolute stoppage of work if there is no substitute for the injured man. It means a less efficient performance of the work if the substitute is not equally skilled and as industrious as the man whose place he takes. If the man is killed instead of injured, the loss is of course far more serious. It has been estimated by a competent authority that it costs not less than $200. to hire and fire a workman in the average machine shop. If we kill a man by accident, we have charged ourselves $200. to do it and to replace him, just the same as if we had discharged him and hired his successor. And this does not take into account the knowledge of the business which may be lost with the death of the workman.

Statistics show that a large percentage of preventable accidents around the workshop result from tripping and falling. These same statistics show that when a previously dark area has been adequately illuminated the accidents from tripping and falling have decreased in a manner that is startling. The moral is obvious.

CHAPTER VIII

Inspection, Rejection and Seconds

THE size of the scrap pile is an index to the inefficiency of the plant. Most scrap piles are entirely too large. They tell a story of wasted material, wasted labor, lost customers and lost profits.

Profit-making production counts only perfect, saleable, merchandise. There is little profit in a big output when a large percentage of it must be classed as "seconds" or scrapped. It is a high net production of "firsts" that marks the efficient plant.

What Does the Scrap Pile Cost?

If you are making articles for stock, you can measure the loss your scrap pile causes you. You know what the raw material in the spoiled work is worth, and how much the lost labor cost. You can add in the overhead expense, and then pocket your loss with more or less cheerfulness. But it is another story when you are manufacturing for a customer. You have promised delivery on a date fixed by yourself. Are you a man of your word? The customer will judge you by the way you keep the delivery promise. An addition to your scrap pile of some of his order, spoiled in process, may hurt him. It certainly will hurt you. His keeping of his word may depend on your keeping yours to him. Will he feel kindly towards you, or place future business with you, if your spoilage causes him to break his delivery promise? The fifty dollars worth of labor and material may be the smallest item to be charged against the spoilage. It will be insignificant alongside the fifty thousand dollars worth of business you did not get because of the delayed delivery due to the addition to the scrap pile.

A famous old professor of mechanical drawing once told a student, "The time to rub out a line is before you draw it." Likewise, the time to repair the damage resulting from spoilage is before the work is spoiled.

Why the Scrap Pile is Large

A careless or inefficient workman is sure to increase the scrap pile. Select the men carefully, fit them to their jobs and train them in their functions. The carelessness and inefficiency will disappear, and the scrap pile will grow less rapidly. Or, perhaps the workman may have but an imperfect understanding of his work. Then the foreman is at fault. It is his place to see that his men do understand, and his is the responsibility for additions to the scrap pile from this cause. But this is as far as we can go in charging the employees with the scrap pile. The management must assume its share of the burden, and it is not a small share.

Imperfect equipment and improper tools are distinctly up to the management. No worker can consistently turn out good work with tools with loose bearings, that are out of alignment, or in semi-darkness. Give the good workman good tools, perfect material, adequate instruction and light enough to see what he is doing and he can be depended on to turn out good work.

No worker can consistently turn out good work in semi-darkness.

Lighting and the Scrap Pile

The provision of adequate equipment does not end

with the machinery. The lighting installation and the heating and ventilating plant, are parts of the equipment that have an influence on the size of the scrap pile. Do you know how great the influence of the lighting equipment is? A census report tells us that we in America spoiled one hundred and fifty million dollars worth of goods in our factories in one year. Thirty million dollars worth of this loss was caused by poor lighting. How? Well, for instance, there is the case of the man running the boring mill, which was illuminated by a bare lamp. As he was setting the tool for the finishing cut he involuntarily glanced at the light, and was blinded for a minute by the brilliant filament. Even after the blindness passed away, the vision of the filament persisted and confused him. He could not see accurately what he was doing, dug the tool into the work, and ruined an expensive casting on which much labor had already been expended. How much real, reflected *illumination*, instead of *light*, would that one spoiled casting have bought?

As he was setting the tool for the finishing cut he involuntarily glanced at the light, and was blinded for a minute by the brilliant filament.

The Inspector and the Scrap Pile

The workman is not the only contributor to the scrap pile. He is aided and abetted by the inspector. Some inspectors will wait until the workman has finished all the pieces of an order before he inspects any. These are the men that make the scrap pile grow. The inspector that is on to his job inspects the *first* piece that the workman makes. Frequently he watches him make it, and inspects between operations. It is an obscure

error that will get away from this procedure. The inspector catches the errors as they occur, points them out and their causes to the workman, and corrects his practice then and there. He makes sure, before he leaves, that the workman knows how to and *can* do the work. Then instead of adding, say, one hundred pieces to the scrap pile, there will be added, at the most, one, and frequently not any.

The inspector is the management's representative in the shop to check up the workmen. It is to the management's own interest to make the work of the inspector as easy as possible. When they give him definite limits between which to work, they are reducing the chances of his adding to the scrap pile. If they draw specifications loosely, the scrap pile will grow. If too much is left to the judgment of inspectors, one will reject what another will pass. The companies which have had foreign governments for their principal customers the past two or three years could tell many a tale about the cost of indefinite specifications.

Giving the Inspector Good Light

Then, too, the management can help the inspector by giving him the proper facilities for his work. Correct gages are furnished as a matter of course. Equally as a matter of course should there be furnished the light in which the gages can be best used. Unshaded lights, with their glare, will cause incorrect reading of micrometers, scales and other measuring instruments. So will too dim a light. The inspector is like other men. He can work

Unshaded lights, with their glare, will cause incorrect reading of micrometers, scales and other measuring instruments.

best when he is comfortable. He must have his work well lighted, and he must be kept warm in winter and cool in summer. Enervating conditions will make an inspector listless and careless—the same as they will any other workman.

The plant that gets the reputation of turning out goods that are uniformly up to specifications will have a much easier time of it with a customer than the plant that is known to be not so careful with its product. The expense of a customer's inspection is a factor in the securing of business. If the customer sees that the product is so carefully inspected in the maker's plant that his own inspection is a useless expense, the securing of contracts will be rendered much easier. Careful inspection pays not only in the operation of the shop, but in the commercial end of the business as well.

CHAPTER IX

Investment and Expense

"YOUR organization cannot be efficient," said a manager of the old school to one of the new, "you have too many non-producers at work." This man had never learned the difference between investment and expense.

An investment is an outlay of money that will bring an immediate or an eventual return. An expense is an outlay that will bring no return. The plant that is aiming at high production will not hesitate to make an investment that will yield adequate dividends. It will keep expenses down to the minimum.

Non-production labor, so called, if rightly used, is so far from being an expense that it is one of the best dividend paying investments that a manufacturer can make.

A low non-productive labor cost today is regarded by those that know as a certain index of inefficiency. All work done in a plant may be divided into two parts, the planning of the work (the deciding as to how it shall be done) and the performing of it.

Planning and Executing the Work

These two functions must be applied to every job and they require frequently very different types of men. The planning of the work in a machine shop for instance involves such factors as the routing of it through the shop, the decision as to the best sequence of operations, the determination of what type of machine is best adapted to a particular part of the work, the determinations of speeds, feeds, cuts and the order of work (which job shall take precedence over the others). Inspection also is frequently made part of the function of the planning department for the reason that the inspector should

not be responsible to the department whose work he may be called upon to reject. It is evident that planning work calls for a man of considerable initiative judgment and executive ability. He, also, must be possessed of a high degree of technical knowledge for some of the work.

It is quite evident that for the performance of the work, a totally different character of man is required. He should be a man skilled in the trade of which he is a part—"finger-wise" is the term applied to him. He should be a man who can take orders and carry them out. He is not necessarily a man who can give orders. The principal requirement in the performance end of the job is skill and the ability to do as one is told.

What is a "Non-Producer"?

Manifestly, if we divide all the work according to the two divisions outlined above, we will increase the number of so-called non-producers in the shop. Every one who works with his head and not with his hands is called a non-producer in the old school of management. Yet the experience of hundreds of concerns has been that by an increase in the number of "non-producers" accompanied by a greater proportionate decrease in the number of "producers," the output of the shop has been doubled, tripled, quadrupled or more.

Good light is another item that is often wrongly classed as an expense.

The ratio of cost of non-productive labor to total payroll may be larger in the shop with a production system than in one without, but the actual cost of a unit of product will be far less.

Like non-productive labor, there are many items of plant equipment and operation that are considered expenses when in reality they should be

regarded as investments. Anything that enables the men and machines to do more and better work is an investment. Even the wages paid to the man who sweeps the floor are an investment, if as a result of clean floors the men will take more pride in their job and do better work.

Good Light is an Investment, Not an Expense

Good light is another item that is often wrongly classed as an expense. What single item in the plant brings greater returns, for the money, than the charge for light, including the cost of the equipment necessary to procure it, the cost of electric current, the cost of maintenance, depreciation and interest? Credit lighting with the value of the increased output it makes possible, the greater earning power of machinery, the saving in spoiled work and the prevention of accidents, and the balance on the credit side of the ledger for the light account will show a bigger return on the investment than probably any other.

The plant manager should not hesitate to make a needed improvement on account of the odious word "expense." He should examine all the circumstances and see if the proposition in question is not an investment instead.

Conclusion

In the foregoing chapters Mr. Kent has discussed some of the important factors of plant operation and their relation to the big problem of production.

In practically every phase of management and operation which Mr. Kent has mentioned—he refers to lighting as an essential factor in the quantity and quality of production.

In other words, according to Mr. Kent, this lighting system in a factory is just as vital as the machinery and the men, and should be considered with due regard for its importance.

In hundreds of plants the lighting system has been so considered and through our Engineering Department we have been called upon to offer advice and help in providing the proper lighting facilities.

This service is offered to you without charge or obligation. A request to the address below or to any of our offices in all large cities will receive prompt attention.

We are thoroughly familiar with plant conditions of all kinds and can advise you as to the lighting facilities that your plant requires.

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